RESEARCH PROGRAM ON Livestock and Fish

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More meat, milk and fish by and for the poor

2012 CIAT annual report on its activities for the Livestock and Fish research program

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ICARDA WorldFish ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE CIAT

CGIAR is a global partnership that unites organizations engaged in research for a food secure future. The CGIAR Research Program on Livestock and Fish aims to increase the productivity of small-scale livestock and fish systems in sustainable ways, making meat, milk and fish more available and affordable across the developing world. The Program brings together four CGIAR Centers: the International Livestock Research Institute (ILRI) with a mandate on livestock; WorldFish with a mandate on aquaculture; the International Center for Tropical Agriculture (CIAT), which works on forages; and the International Center for Research in the Dry Areas (ICARDA), which works on small ruminants. http://livestockfish.cgiar.org

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A. Key Messages

A.1 Summary

CIAT is contributing to the Livestock and Fish CGIAR Research Program mainly through two avenues, i.e. 1) development of forage options through selection and breeding as part of the feeds theme and 2) Integration of novel forages and – with partners – enhancement of livestock systems for livelihood and environmental benefits in target value chains. CIAT is coordinating the dairy value chain in Nicaragua and Honduras and contributes to the dairy value chain in Tanzania and pig value chains in Uganda and Vietnam. Specific information on advance in value chains is reported in the respective value chain reports.

A.2 Most significant achievements/success stories

Candidate story – Feeds theme. Alternative forage legume based feeds developed and integrated into systems. The advances made are mostly the outcome of a BMZ-GIZ funded project: More chicken and pork in the pot, and money in pocket: Improving forages for monogastric animals with low-income farmers, carried out in collaboration with the Instituto Nicaragüense de Tecnología Agropecuaria (INTA), Nicaragua; **Universidad Nacional de Colombia-Palmira, Colombia (UNAL-Palmira);** Universidad del Cauca, Colombia; Consortium for Improved Agriculture-based Livelihoods in Central Africa (CIALCA), DR of Congo (Sud-Kivu mandate area); Universite Evangelique en Afrique; University of Rostock, Germany, and University of Hohenheim, Germany. Suitability of forages as feed for pigs and poultry was assessed indicating the potential of tropical forages for monogastric feeding in terms of biophysical and socioeconomic feasibility, though the latter outside the target value chains of Livestock and Fish sites were defined prior to implementation of the program, however results are useful for reference in the value chain work of the program.

Species and accessions including *Vigna unguiculata*, *Canavalia brasiliensis*, *Lablab purpureus* and *Cratylia argentea* were identified, tested and validated. In general, digestibility of the alternative feeds was better in pigs than in broilers. Pigs (with an initial liveweight of at least 15 kg) tolerate well up to 33% of, for instance, *Vigna* with similar live weight gain compared to a conventional diet and lower costs, and with good results with improved breeds and good management. Intake improves with increasing dry matter concentration and small particles size (herbage meal>silage>fresh). Ensiling clearly reduced some anti-nutritional factors such as oxalic acid and tannins, which allows one to include the more "problematic" shrub legumes such as *Leucaena* sp. to be included in a monogastric diet. For poultry, the inclusion of herbages is much more restricted; grains however may be an option depending on the available alternatives. The *in-vitro* enzymatic degradability of forages for pigs shows some deviation from the one found *in-vivo*. This hints to a different dynamic in the *in-vitro* process in some cases, which have to be explored further.

On-farm experiments and/or training and farmer-to-farmer events involved at least 400 farmers and were implemented in strong collaboration with national research institutes and universities in Nicaragua, Colombia and DRC. The three countries presented each their specific conditions, and in particular DRC proved challenging in terms of poverty, lack of infrastructure and insecurity. Forage based feeds were generally used on farm, but it was not yet feasible to establish value chains for commercialization. Some striking emerging results included the importance and potential of cavies in DRC and the potential of silage for smallholders in Nicaragua and Colombia. In all countries, gender turned out to be an important component and we were able to focus our activities for a very important part on women and youth. In Colombia, an important constraint for production of protein concentrates based on forages by the feed industry is the focus on day-to-day feed markets with limited price margins. In Nicaragua, production of alternative feeds on farm is a promising opportunity to enhance availability of protein feed compared to an otherwise

energy-accented diet. In both countries the largest potential is for pigs. Knowledge transfer to and between farmers and institutions was part and parcel of the research for development process through co-development of technological options and training opportunities at various levels. Further dissemination requires intensification of linkages with the organizational networks addressed in the project. Some farmer extension materials were developed. Possibilities for linking smallholder farmers with the formal feed sector will depend on development of the sector in view of purchase of raw materials for feed formulation. While alternative feed options have been identified, further research to application on farm and processing is needed. Although the focus of research was on the forage/feed component, the work also contributed to increasing farmers' interests in and improving other components of the monogastric production systems, such as housing, genetics and hygiene. Further research needs to include the use of leguminous shrubs and trees, processing of forages for monogastric feeding and further refinement of a rapid procedure to analyze alternative feeds. It is also important to better understand the socio-ecological niches for forages on farm, which includes understanding the underlying factors that can either promote or impede the possible adoption of forage cultivation.

A.3 Financial summary for 2012: total expenditure, percentage allocated to gender research and total funding (from all sources, including bilateral and window 3) compared to expected budget. (Your Finance office should be able to generate this directly from the templates they have been sent and are to submit by Feb 15th)

	Expenditures						**Budget**				
	Windows 1 & 2	**Window 3**	**Bilateral funding**	**Center funds**	**Total Funding**		**Windows 1 & 2**	**Window 3**	**Bilateral funding**	**Center funds**	**Total Funding**
Theme 1											
Theme 2											
Theme 3	783,759		898,309		1,682,068		711,776	196,000	1,360,454		2,268,230
Theme 4	373,808		451,510		825,318		446,116		722,785		1,168,901
Theme 5											
Theme 6	17,456		144,968		162,424		18,009		239,020		257,029
CRP Management											
Total – all Costs	1,175,023		1,494,787		2,669,810		1,175,901	196,000	2,322,259		3,694,160
Gender Strategies											

B. Impact Pathway and Intermediate Development Outcomes (IDOs)

N/A

C. Progress along the Impact Pathway

C.1 Narrative of major achievements, by Theme

Progress in germplasm development (through breeding and selection) is assessed through the identification of new technologies adapted to specific biophysical and socioeconomic production niches. Progress in terms of inclusion into systems is measured through biophysical characteristics (i.e. yield, adaptation to stresses, forage quality) against forage control checks underutilization, through assessment of environmental implications, for bred grasses through seed sales and through periodic monitoring and impact assessment.

C.2 Progress towards outputs

CIAT- Feeds theme (the value chain theme is reported in the respective value chain reports as mentioned above (i.e. the dairy value chain in Nicaragua and Honduras and Tanzania, and pig value chains in Uganda and Vietnam).

Major progress had been made in identifying alternative forage legume based feeds for monogastrics as reported in the case study stated above.

In forage development, two avenues are followed, 1. through breeding focusing on the *Brachiaria* genus. We are currently running two Brachiaria breeding programs, a) *Brachiaria decumbens* x *B. brizantha* x *B. ruziziensis* hybrids and b) *B. humidicola* hybrids and 2. through selection of forages from wild relatives, focusing largely on forage legumes (see progress reports; Brachiaria (RxDxB) Breeding Program and Developing a broad-based, synthetic sexual B. humidicola breeding population in the program wiki page: http://livestock-fish.wikispaces.com/VCD+Nicaragua reports). Forage development takes into consideration production parameters such as tolerance to biotic and abiotic stresses as well as environmental considerations e.g., the Biological Nitrification Inhibition capacity of *B. humidicola*. In view of increased vulnerability of systems in particular of smallholders we focus on more constrained environments with combined tolerance to low fertility, drought and waterlogging. For *Brachiaria decumbens* x *B. brizantha* x *B. ruziziensis* hybrids we follow a 3 year breeding cycle, so far three cultivars have been released. With *B. humidicola* we are making progress towards commercial cultivars available likely in the next 5 years. *Brachiaria* hybrids are commercialized through agreements with the private seed sector. For legumes we emphasize the evaluation of core collections, commercialization so far mostly focusing on artisanal production of seed and/or vegetative material across tropical America, Africa and Asia.

C.3 Progress towards the achievement of outcomes

The *Brachiaria decumbens* x *B. brizantha* x *B. ruziziensis* breeding program provides a continued stream of potential new cultivars in 3 year intervals, while for *B. humidicola* we are advancing towards delivery of commercial products. Numbers of lines at the initiation of the breeding cycles are usually high, with between several hundred and several thousand lines. After a 3 year evaluation cycle we deliver selected lines to private sector and research partners for further testing. Further research accompanies this process assessing the environmental implication mostly emphasizing mitigation of greenhouse gas emissions. From core collections of legumes and selected grasses we do identify a small set of elite lines to be tested with partners

C.4 Progress towards Impact

Uptake of lines from the *Brachiaria* breeding programs is extrapolated through seed sales, supported with periodic impact studies. So far we have not been able to present in a gender disaggregated form. Over the last 10 years 400 to 500 Tsd ha have been sown with Brachiaria hybrids originating from CIAT, figures for 2011 are estimated at 50 to 75 Tsd additional ha, with 2012 pending, following a trend of exponential increases of time. For legumes we are identifying best bets from *Tadehaghi* and *Desmanthus* collection and working toward cultivar release in 2014 of *Canavalia brasiliensis* in Colombia while in Nicaragua *C. brasiliensis* through our NARS partners in 2012.

C.5 Traffic Light Reporting of Progress against Outputs

For calendar year 2012 **Center : CIAT**		
Output Targets	**Status**	**Explanation and evidence**
3.1.3.1.1. Improved grasses developed through breeding for sustainable intensification of tropical crop-livestock systems	Accomplished	
Milestone B. *humidicola* breeding: Identification of sexually reproducing, hybrid derived clones; sexual recombination of these, by open-pollination		Recombination block of 325 sexual, hybrid-derived clones established (at CIAT-Popayán station). Sexual, hybrid-derived clones identified (by progeny-test); vegetatively propagated; transplanted to field recombination block in May 2012; See report in the wiki page: Developing a broad-based, synthetic sexual B. humidicola breeding population
Milestone *Brachiaria decumbens* x *B. brizantha* x *B. ruziziensis:* Promising hybrids identified on field performance; Seed harvested for progeny trial and further evaluation for biotic (insect and disease) and abiotic (drought, waterlogging, aluminum toxicity) stress tolerance		Field evaluation (replicated, space-planted field trial) of 2,730 new testcross hybrid genotypes; culling to 150 hybrids on field performance (e.g. vigor) and seed set; seed for progeny-test harvested; [promising hybrids screened for biotic and abiotic stress tolerance and nutritional quality (2013)]. See report in the wiki page: Brachiaria (RxDxB) Breeding Program
3.1.3.1.2 Improved forages selected to enhance eco-efficiency of tropical crop-livestock systems	Accomplished	
Milestone Alternative forages based feeds for monogastric feeding available to smallholder farmers		Set of alternative forage-based protein feeds analyzed for theoretical value and productive value in animals Effects of processing assessed Participatory field evaluation Gender-differentiated socio-economic assessment, and market analysis Partner network mapping
Milestone: Identification of shrub legumes for use in tropical smallholder systems		List of *Tadehagi* accessions suitable for utilization in smallholder systems

List of publications in ISI journals	Aguirre, L.M., C. Cardona, J.W. Miles, and G. Sotelo. Characterization of resistance to adult spittlebugs (Hemiptera: Cercopidae) in *Brachiaria* spp. J. Econ. Entom.106(4):1871-1877. http://dx.doi.org/10.1603/EC11189 Alvarez, E., Latorre, M., Bonilla, X., Miles, J.W., Sotelo, G., 2013. Diversity of *Rhizoctonia* spp. causing Foliar Blight on *Brachiaria* in Colombia and Evaluation of *Brachiaria* Genotypes for Foliar Blight Resistance. Plant Disease 97(6):772-779). Available at: http://dx.doi.org/10.1094/PDIS-04-12-0380-RE Heinritz S, Martens SD, Avila P, Hoedtke S (2012) The effect of inoculant and sucrose addition on the silage quality of tropical forage legumes with varying ensilability. Animal Feed Science and Technology 174, 201-210. Available at: http://dx.doi.org/10.1016/j.anifeedsci.2012.03.017, Heinritz SN, Hoedtke S, Martens S, Peters M, Zeyner A (2012) Evaluation of ten tropical legume forages for their potential as pig feed supplement. Livestock Research for Rural Development 24, #7. http://www.lrrd.org/lrrd24/1/hein24007.htm Maass, B.L., Katunga-Musale, D., Chiuri, W.L., Gassner, A. and Peters, M. 2012. Challenges and opportunities for smallholder livestock production in post-conflict South Kivu, eastern DR Congo. Tropical Animal Health and Production 44(6):1221-1232 Available at: http://dx.doi.org/10.1007/s11250-011-0061-5 Martens SD, Tiemann T, Bindelle J, Peters M, Lascano CE: Alternative plant protein sources for pigs and chickens in the tropics - nutritional value and constraints: a review. Journal of Agriculture and Rural Development in the Tropics and Subtropics. Available at: http://nbn-resolving.de/urn:nbn:de:hebis:34-2012092441794

	Douxchamps, S., E. Frossard, N. Uehlinger, I. Rao, R. van der Hoek, M. Mena, A. Schmidt and A. Oberson. 2012. Biomass production of Canavalia brasiliensis in the Nicaraguan hillsides. Journal of Agricultural Sciences 150: 675-690 Available at: http://dx.doi.org/10.1017/S0021859611000931 Subbarao, G. V., K. L. Sahrawat, K. Nakahara, T. Ishikawa, N. Kudo, M. Kishii, I. M. Rao, C. T. Hash, T. S. George, P. S. Rao, P. Nardi, D. Bonnett, W. Berry, K. Suenaga and J. C. Lata. 2012. Biological nitrification inhibition (BNI) – A novel strategy to regulate nitrification in agricultural systems. Adv. Agron. 114: 249-302. Available at: http://dx.doi.org/10.1016/B978-0-12-394275-3.00001-8 Peters, M., I. Rao, M. Fisher, G. Subbarao, S. Martens, M. Herrero, R. van der Hoek, R. Schultze-Kraft, J. Miles, A. Castro, S. Graefe, T. Tiemann, M. Ayarza and G. Hyman. 2012. Tropical forage-based systems to mitigate greenhouse gas emissions. In: C. Hershey (Ed.) Issues in Tropical Agriculture I. Eco-Efficiency: From Vision to Reality. CIAT, Cali, Colombia. Available at: http://cgspace.cgiar.org/handle/10568/17234 van der Hoek, R., M. Peters, M. Mena, R. Schultze-Kraft, A. Schmidt and I. Rao. 2012. Tropical forages to enhance sustainable intensification of mixed systems in Central America and the Caribbean. IN: Proceedings of the 66th Southern Pastures and Forage Crop Improvement Conference. San Juan, Puerto Rico, June 6-9, 2012: 34 (invited paper). http://spfcic.tamu.edu/spfcic/Proceedings%2066th%20SPFCIC%5B1%5D.pdf
List of flagship products/ technologies/tools/ policies produced - Indicate with * those having an explicit target of women farmers - Indicate those assessed for likely gender-disaggregated impact; if not, provide the rationale why the given product does not qualify for this assessment	Peters, M., I. Rao, M. Fisher, G. Subbarao, S. Martens, M. Herrero, R. van der Hoek, R. Schultze-Kraft, J. Miles, A. Castro, S. Graefe, T. Tiemann, M. Ayarza and G. Hyman. 2012. Chapter 13. Tropical forage-based systems to mitigate greenhouse gas emissions. In: C. Hershey (Ed.) Issues in Tropical Agriculture I. Eco-Efficiency: From Vision to Reality. CIAT, Cali, Colombia. See publication: http://ciat.cgiar.org/new-publications

List open access databases maintained and indicate number of users	
List electronic media such as knowledge banks, CRP and institutional home portals, websites, other ICT media used for information dissemination; indicate number of hits/views/requests	www.tropicalforages.info (together with CSIRO, QDPI, ILRI and FAO), currently about 20,000 visits monthly
List short and long term capacity development programs; Indicate number of trainees for each, sex-disaggregated, developed/developing country of origin	
List MSc and PhD students supervised, indicating gender, developed/developing country of origin	3 (male), Cuba, Germany, DR of Congo Artiles, E. 2012. Evaluación de alimentos fibrosos tropicales para la alimentación de cerdos en crecimiento en Nicaragua. Master thesis University of Santa Clara, Cuba. Burkart, S. 2012. Improving Business Models of Smallholder Pig and Poultry Producers in Colombia and Nicaragua –Potentials of Sustainable Value Chain Development. University of Hohenheim, Germany, 261 pp. Muhimuzi-Lwaboshi, Fabrice. 2012. Etude de comportement de dix légumineuses fourragères herbacées exotiques dans le Bushi montagneux [In French; Study of the adaptation of ten exotic herbaceous forage legumes in the hilly Bushi region]. Memoire, equivalent to BSc thesis to obtain an A0 degree in agronomy at the Université Catholique de Bukavu, Bukavu, DRC. 74 pp. plus annexes.
List meetings/workshops/seminars with a significant science-policy interface (e.g. multiple high-level policy makers present)	
List countries which are using the CRP results to define or modify national policies and strategies, noting which results and evidence	
List significant national or international agencies, private sector actors using the tools and results from the CRP in their on-the-ground implementation efforts, specifying which tools and results and evidence - Indicate number of times that the outputs from the CRP are being used to enhance gender equality	Commercialization of *Brachiaria* hybrids through Private Seed Sector
List specialized genetic stocks (accessions and genotypes of wild relatives and landraces, special mapping populations, mutation	All evaluation selecting forages (mainly legumes) from wild relatives

stocks, etc.) for gene discovery and pre-breeding	
List published/identified new genes, markers, or QTLs and made available to scientists and breeder globally	
List new germplasm with improved traits shared with (public and private sector) partners for testing and release (via international trials and nurseries)	Selected set of accessions of *Canavalia brasiliensis* in testing with NARS for cultivar release in Nicaragua and Colombia, testing and introduction of improved forage germplasm in Rwanda, DR. of Congo, Kenya, Uganda, Tanzania; Colombia, Nicaragua, Honduras, Cuba: Cambodia, Vietnam, Laos
List International Nurseries, Yield trials, PVS, etc. for germplasm evaluation conducted by CRP partners	
List varieties with CRP-parentage released by public and private sector partners globally	*Brachiaria decumbens* x *B. brizantha* x *B. ruziziensis:* Mulato 1 and 2, Cayman (names can vary according to reléase in specific countries
List strategic value chains analyzed	Dairy value chain Nicaragua and Honduras (to be found at Wiki, http://livestock-fish.wikispaces.com/file/view/Dairy+Value+Chains+Workshop+Results+-+eng.docx , with ILRI dairy Tanzania, pigs in Uganda and Viet Nam
List post-harvest technologies tested by the CRP and under dissemination by partners (including value-chain actors);	
Acreage under the CRP crop, total production, average farm yields, average profitability for small-scale farmers, number of small-scale producers Farm and plot level data should be broken down by different levels of poverty. Farm and plot-level data should be sex-disaggregated using the relevant units for showing gender inequality (i.e. in regions where intra-household gender inequality is significant, plot or area cultivated by men or women or the distribution of profits between men and women may be used in lieu of female-headed farm or household).	*Brachiaria* bred lines currently about 500 Tsd ha, carrying capacity increased to 2 to 3 animals per ha (against baseline of 0.7 to 1.2 animals per ha), meta-analysis of forage impacts underway (available end of 2013)
List systems (with estimated population) analysed/characterised and system drivers identified (dis-aggregated for how they support different socio-economic groups)	
List systems (with estimated population) in which the CRP is organising R4D platforms, specifying the platforms	
List systems for which innovations (technologies, policies, practices,	

integrative approaches) and options for improvement at system level have been developed, specifying the relevant innovations or options - Identify by * innovations that are targeted at decreasing inequality between men and women in the regions where the CRP is working	
List published research outputs utilised in targeted systems by CRP partners, noting which partners	
List systems for which CRP has identified feasible approaches for improving ecosystem services and for establishing positive incentives for farmers to improve ecosystem functions as per the CRP's recommendations (specify the types of services)	
Estimate the number of people who will potentially benefit from plans, once finalised, for the scaling up of strategies, giving your rationale	

D. Gender research achievements

n/a

E. Partnerships building achievements

The CIAT Tropical Forages Program currently focuses on Tropical America, Southeast Asia and East and Central Africa. Formal interactions are established through partnership in Humidtropics and CCAFS. Potential for further interaction exist mainly with CRP 2 and CRP 5.

F. Capacity Building

Provide a summary and highlights of training -short and medium term trainings (in all categories of capacity building, not just scientific)- and its outputs and outcomes (half page). Use indicators from the common list, as appropriate.

G. Risk Management

List of the three to five major risks that could hinder the expected delivery of results by the CRP from your perspective and provide a description of the mitigation actions taken to better manage these risks.

- Existence of strong linkages with other CRPs, Policy and Research and Development partners. Mitigated by efforts in networking though policy changes remain a high risk
- Continued agreement with the Private Seed Sector. Mitigated by delivering outputs of commercial relevance
- Extreme weather events, in particular as we are focusing on vulnerable environments where a large part of poor smallholders are located. Mitigation through development of resilient technologies

H. Lessons Learned

- Analysis of variance from what was planned:
  i. Description, if relevant, of research avenues that did not produce expected results, and description of implications for the CRP, such as new research directions and their expected outputs and outcomes.

  ii. Discussion of the cost and budget implications of the variance from the planned CRP.

  iii. In the light of the progress accomplished, confirm whether the original impact pathways in the proposal still stand or if amendments are needed to achieve expected impact. Implications of these amendments for the partnerships of the CRP.